



Analyze Smarter

MORE INFORMATION; BETTER SOLUTIONS



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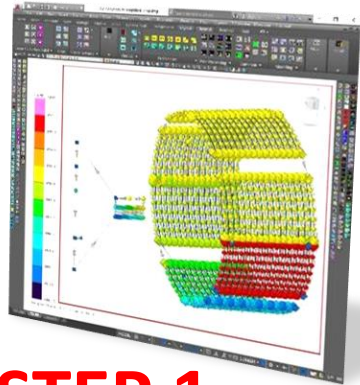
www.Veritrek.com



What is Veritrek?

REDUCED-ORDER MODELING TO ENHANCE THERMAL DESKTOP®

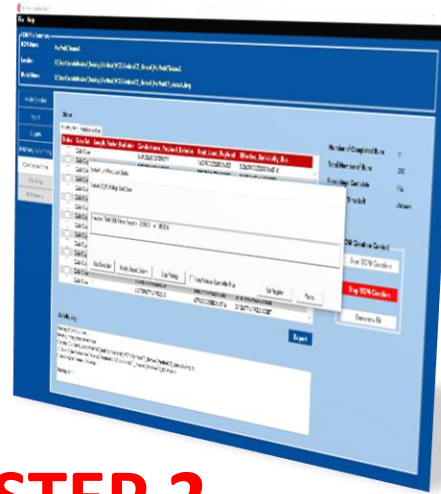
Thermal Desktop® 



STEP 1

Select Thermal Model

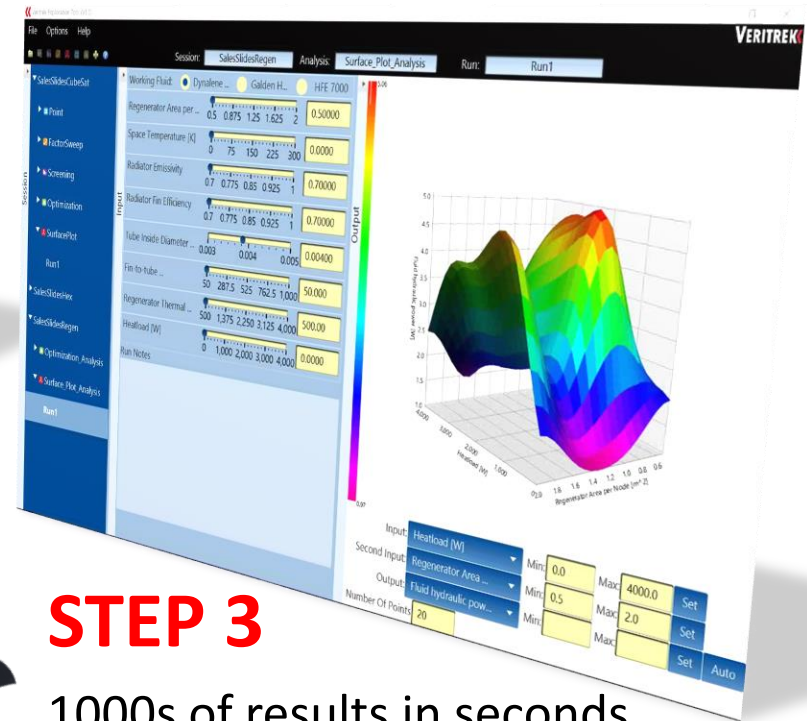
Creation Tool



STEP 2

Convert to reduced-order model.

Exploration Tool



STEP 3

1000s of results in seconds.



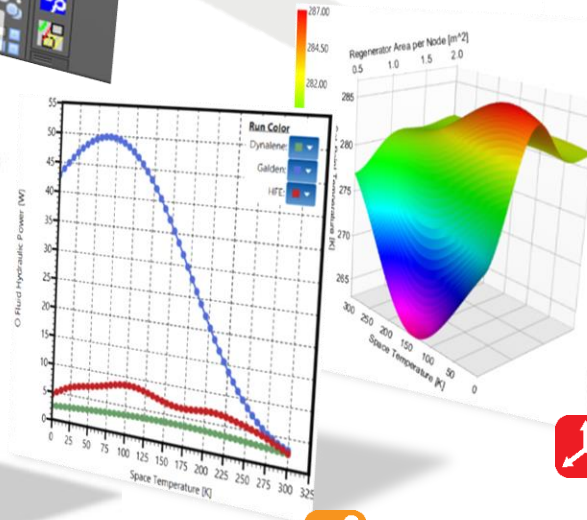
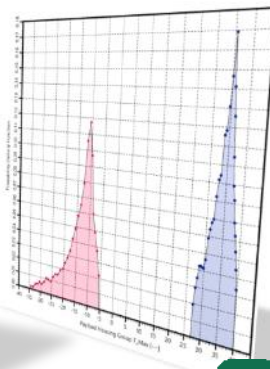
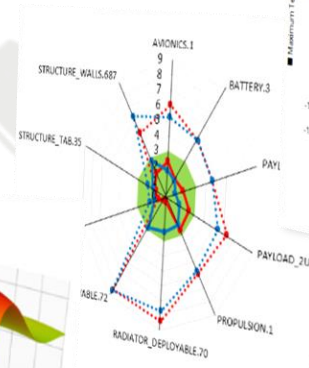
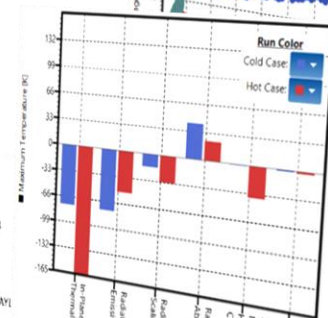
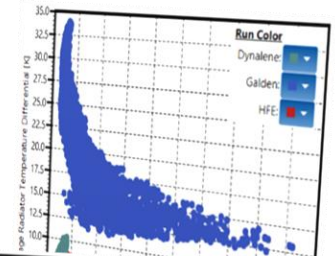
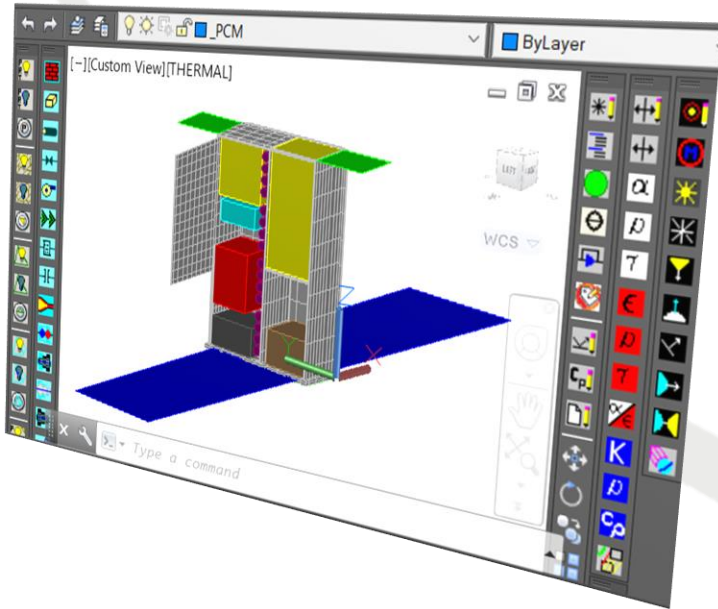
Why Veritrek?

Thermal Desktop®



MORE INFORMATION LEADS TO BETTER SOLUTIONS

Powerful
Minutes to hours/simulation
Worst-case analyses



Node	Area	Volume	Mass	Weight	Center of Gravity	Radius of Gyration	Area Moment of Inertia	Section Modulus	Area Moment of Inertia	Section Modulus
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
3	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
5	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
6	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
7	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
8	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
9	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
10	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0



VERITREK

1000s of simulations in seconds
Expanded analysis
Improved understanding



What is a ROM?

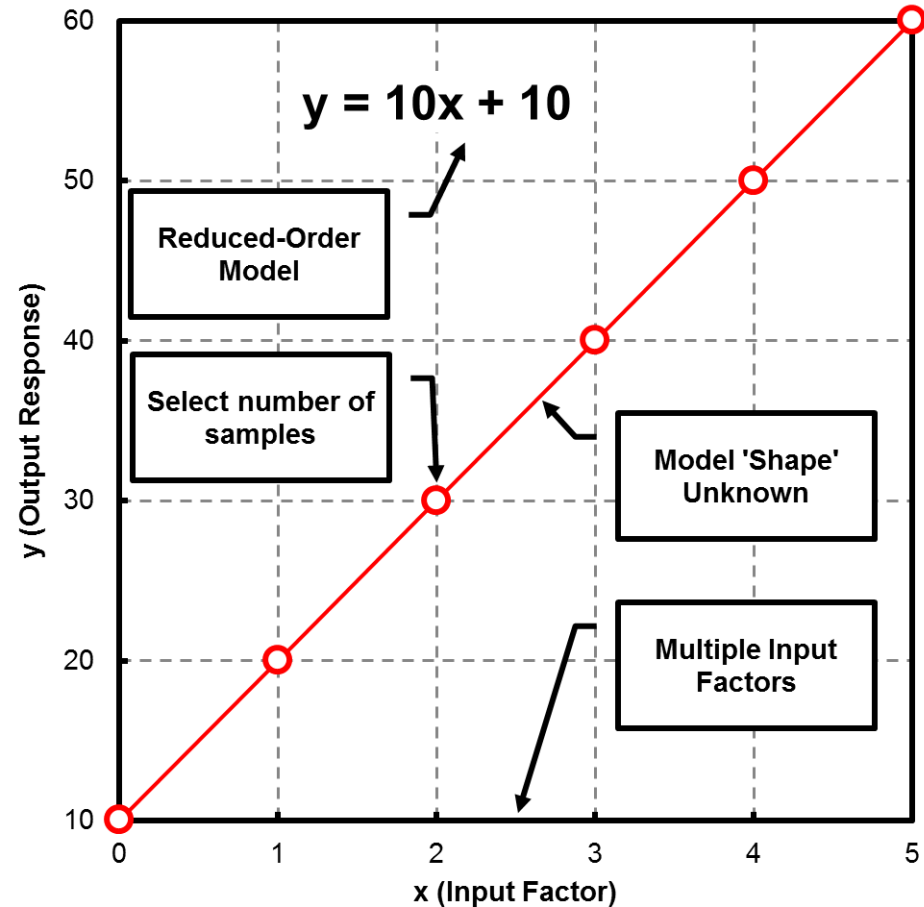
ACCURATE SURROGATE OF A HIGH-FIDELITY MODEL

A statistical emulator

- Intelligent sampling
- Robust data fitting

Veritrek provides

- Multiple input factors
 - Most to date is 33
- Multiple output responses
 - Most to date is 91

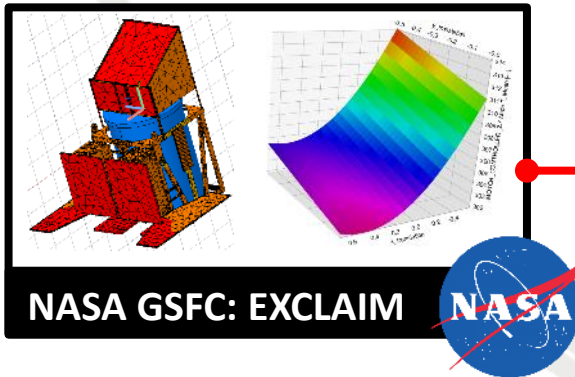




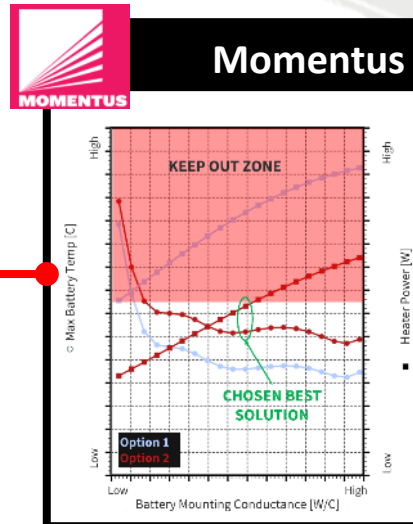
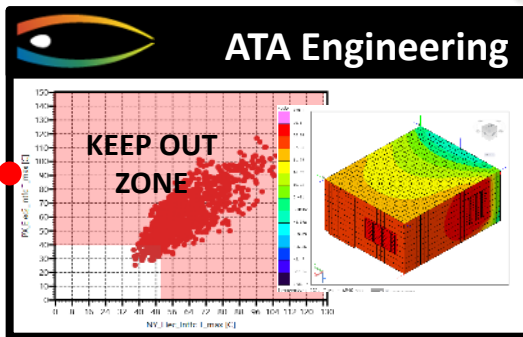
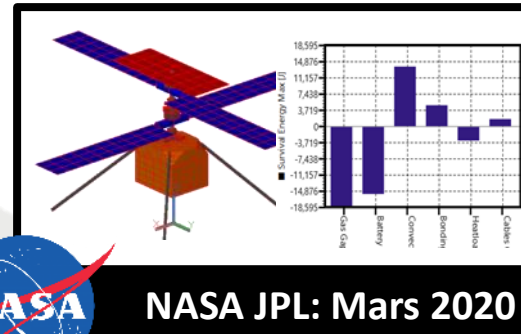
When can you use Veritrek?

MULTIPLE AREAS OF A DESIGN LIFE CYCLE

Early Design
Trade studies

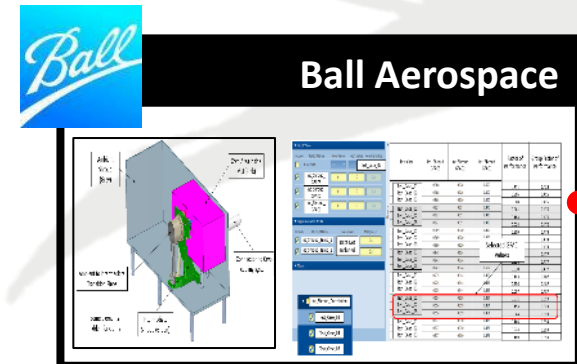


Detailed Design
Sensitivity Studies



AI&T

Model Correlation



Detailed Design
Design Optimization

Final Design
Design Verification



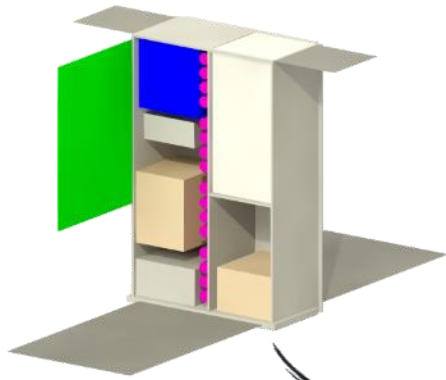
DEMO



How to build a ROM

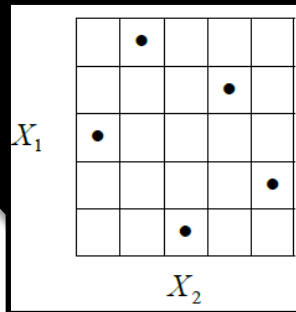
VERITREK CREATION TOOL

Thermal Desktop® 



Import symbols,
registers, nodes,
case sets, etc.

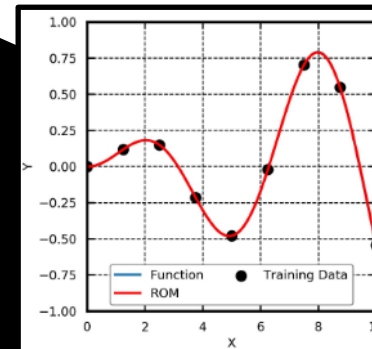
ROM Setup



Create training runs

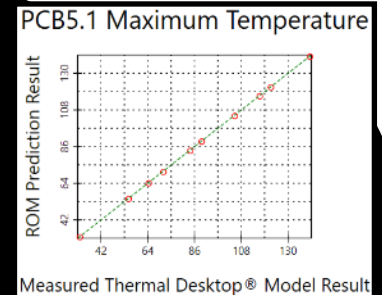
Creation Tool

Generate training data
and Perform data-fit



ROM Creation

Determine ROM
accuracy



ROM Testing

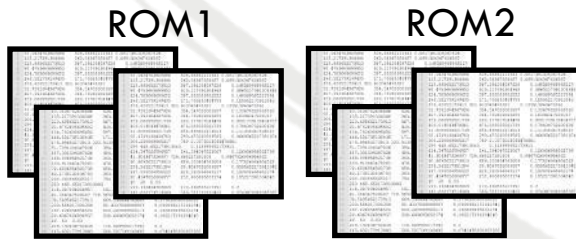


Please don't hesitate to ask questions.



How to use a ROM

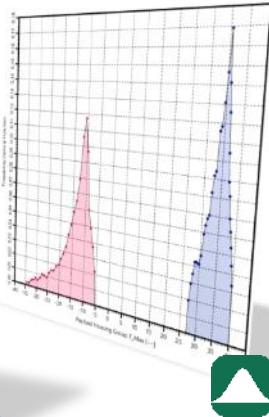
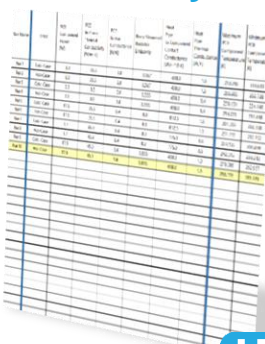
Creation Tool



Import multiple ROMs into the Exploration Tool

Uncertainty Quantification

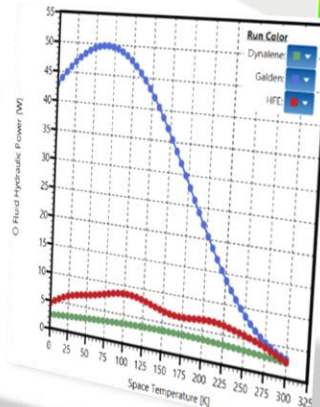
Point Analysis



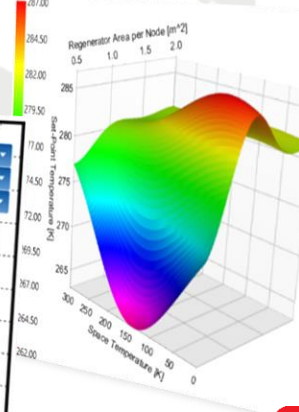
Exploration Tool

Multiple ROMs and analyses session management

Factor Sweep



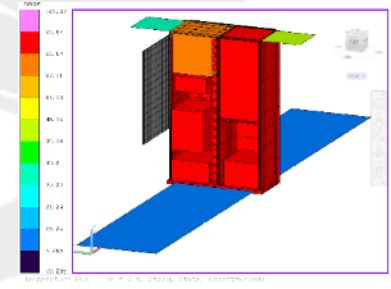
Surface Plot



Model Correlation



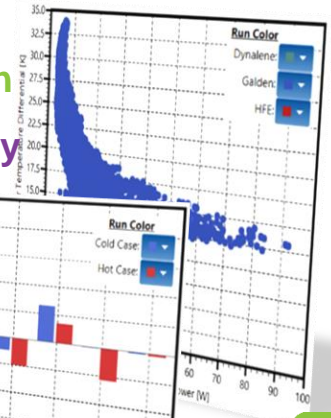
Run final solution



VERITREK EXPLORATION TOOL

Design Optimization

Sensitivity Study



Thermal Desktop®





Please don't hesitate to ask questions.



NEW FEATURES



- Reduce the time it takes to create a ROM

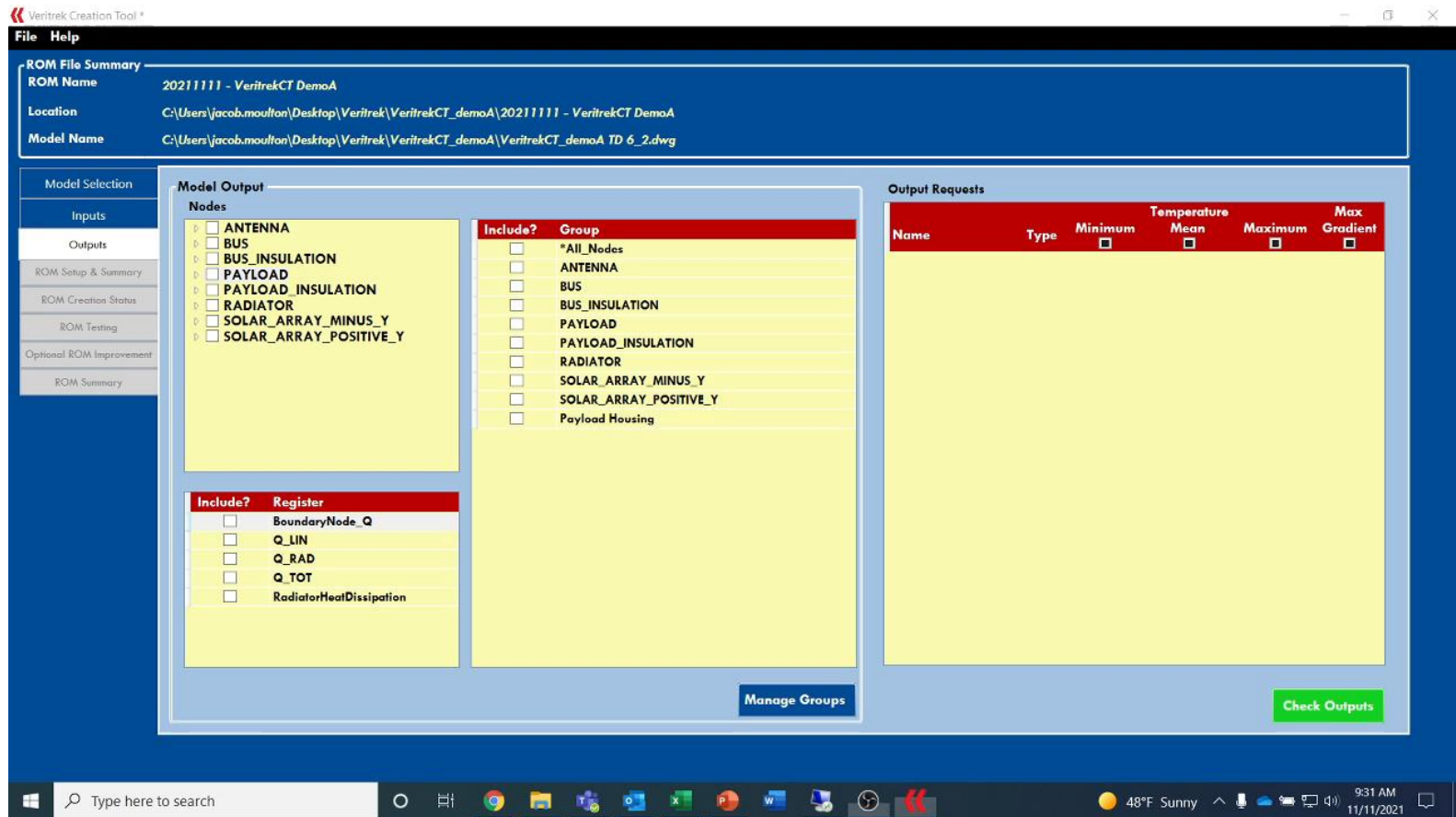




In case you missed it in Veritrek v4.1

Compatibility with Thermal Desktop 6.2

Max Temperature Gradient of a Node Group has been added as an output response





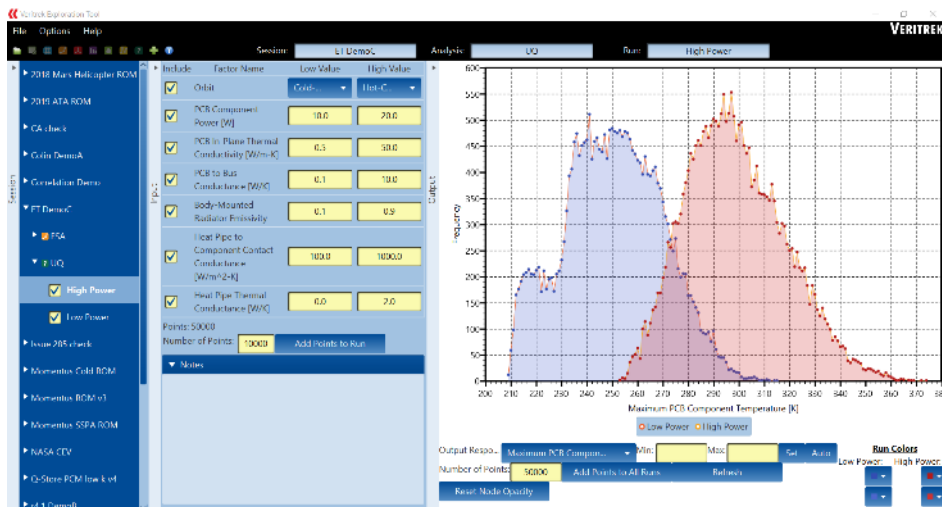
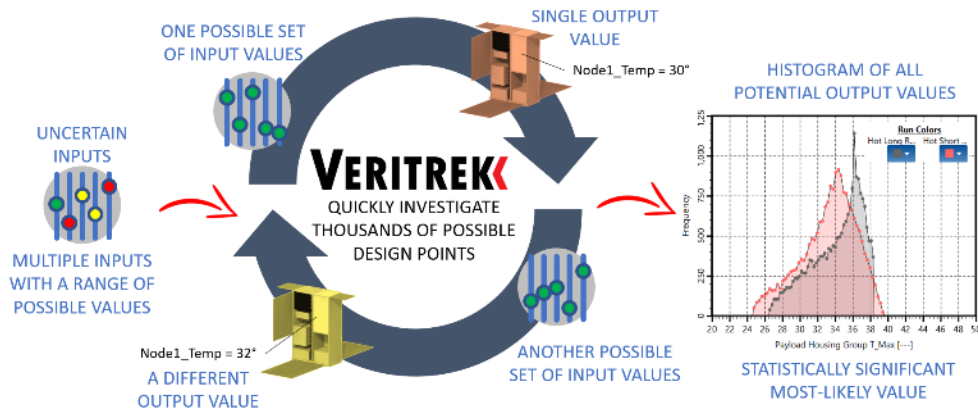
In case you missed it in Veritrek v4.2

WHAT'S NEW IN VERITREK 4.2?

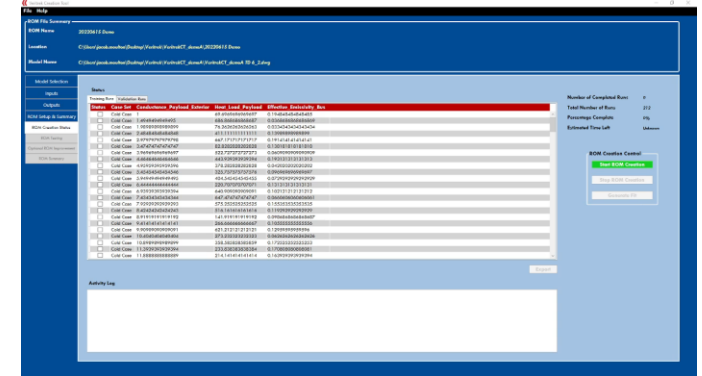
Uncertainty Quantification Feature

- Make statistically based conclusions about the uncertainty of a model

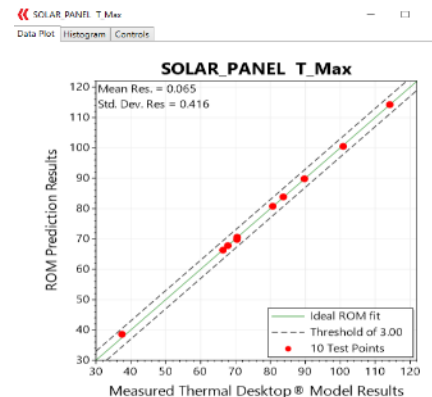
Understand the statistical impact of your model's uncertainty, based on thousands of data points



Smart-order of training runs



Updated Test Results and Data-fitting Time Tracker



Training Data Fitting
Veritrek is now running your training data through our data-fitting algorithm. Estimated Time Left = 00:08:00



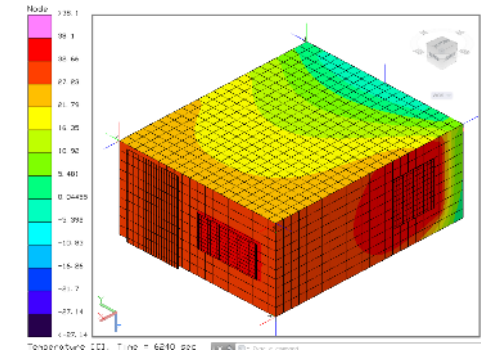
CASE STUDIES



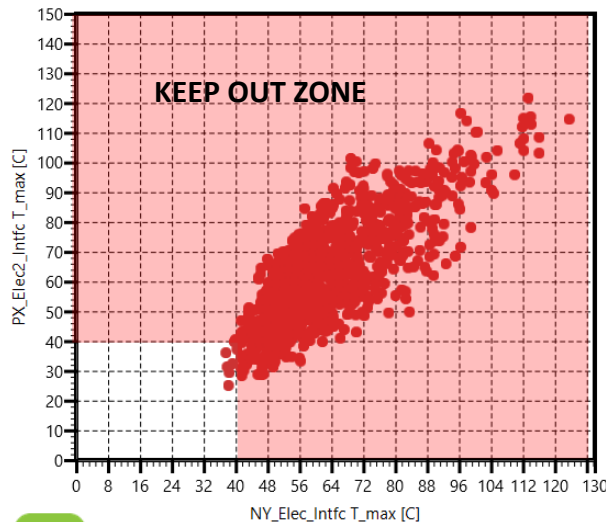
ATA Engineering: SmallSat Radiators

CUSTOMER SUCCESS STORY

Veritrek enabled optimization of body-mounted radiator sizes



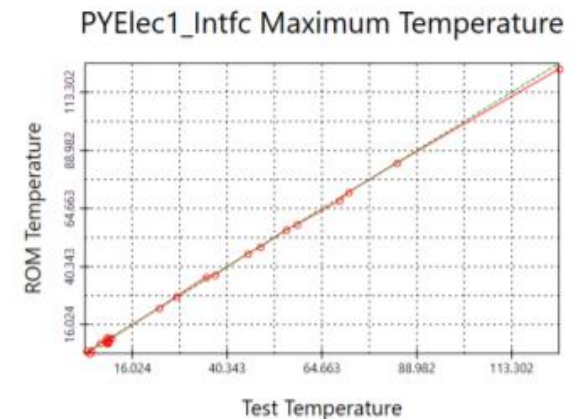
6 Input Factors
10 Output Responses
256 training runs (~88 hours)



Orbits	Rad1	Rad2	Rad3	Rad4	Rad5	Rad6
Cold Case	0.95	0.32	0.33	0.435	0.41	0.25
Hot Case	0.95	0.32	0.33	0.435	0.41	0.25

T_max [C]				
Elec1	Elec2	Elec3	Elec4	Elec5
-15.711	-8.46	-15.14	7.795	-1.68
39.584	31.446	31.614	32.247	35.75

Required Heater Energy [J]				
Heater1	Heater2	Heater3	Heater4	Heater5
32.41	32.663	12.078	39.276	2.82
0	0	0	0	0



Test Results

 Optimization Analysis

 Point Analysis

 REDWIRE VERITREK

www.Veritrek.com



Momentum: Vigoride

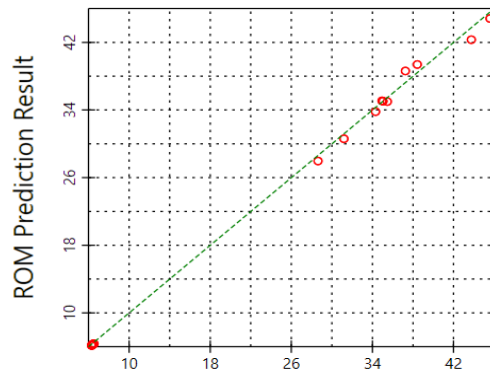
CUSTOMER SUCCESS STORY

Veritrek provided insight into confident design decisions

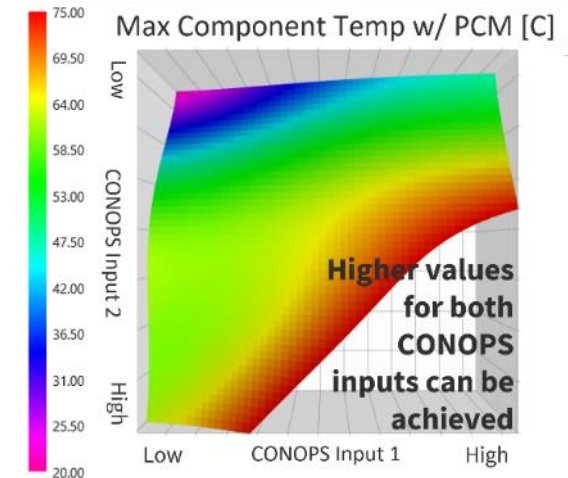
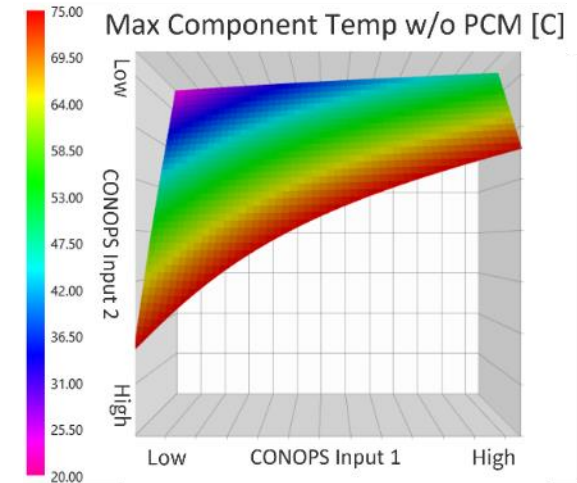
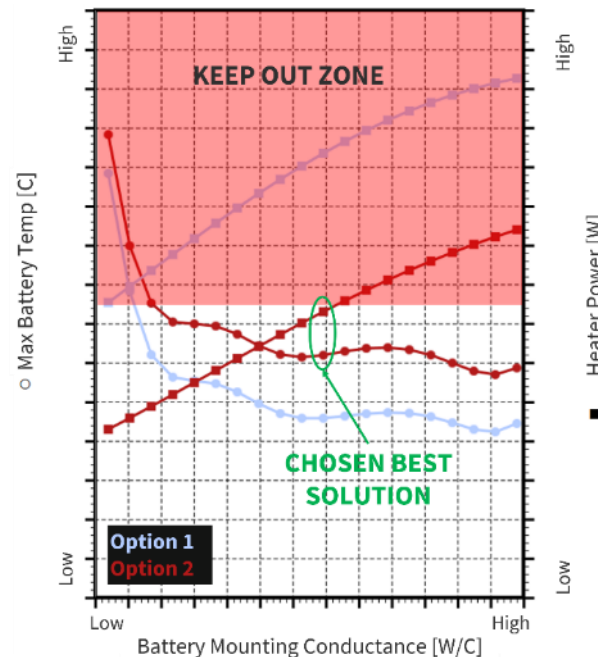


Veritrek helped close the thermal design prior to CDR and allowed for early investigation into future mission planning.

7 Input Factors
28 Output Responses
212 training runs
BATTERY T_{Max}



Measured Thermal Desktop® Model Result

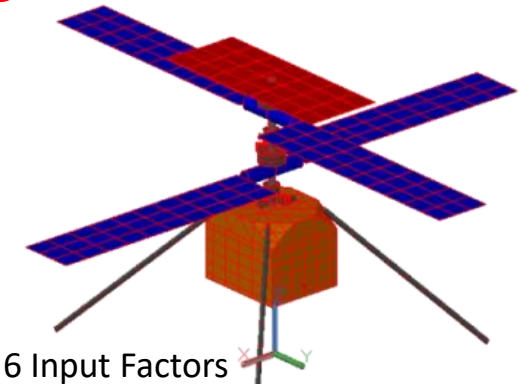




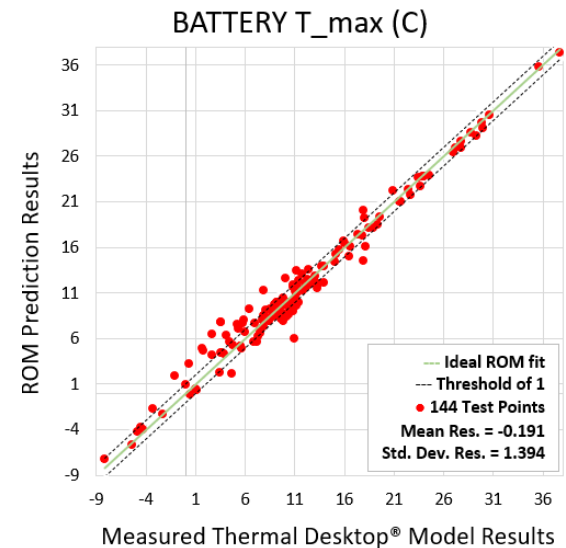
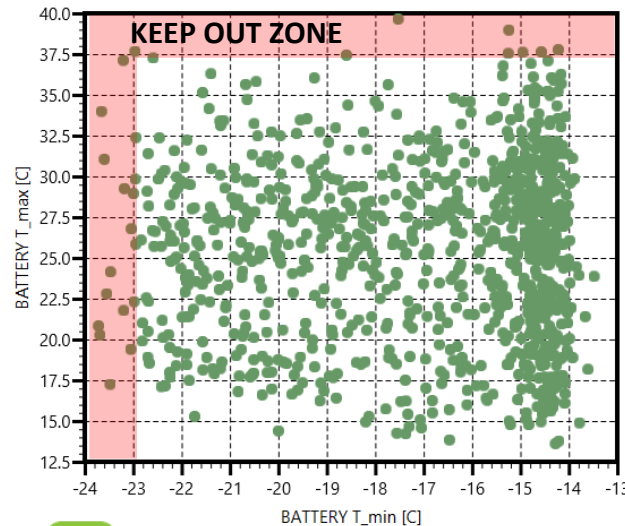
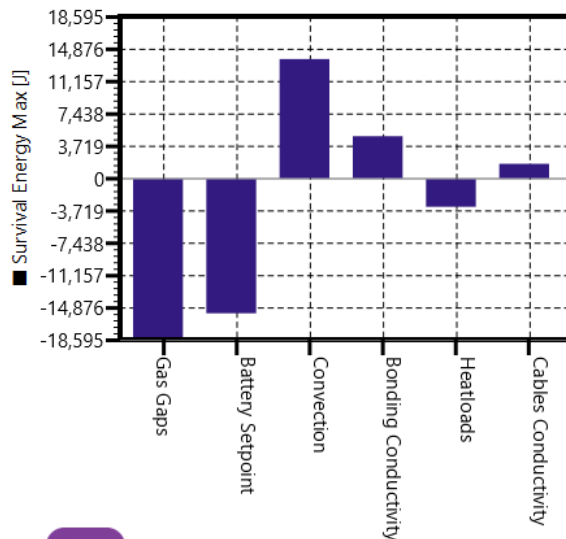
NASA JPL: Mars Helicopter Thermal Design

CUSTOMER SUCCESS STORY

Veritrek enabled evaluation of thermal design sensitivities



6 Input Factors
36 Output Responses
452 training runs (~248 hours)



Screening Analysis



Optimization Analysis



www.veritrek.com

Test Results

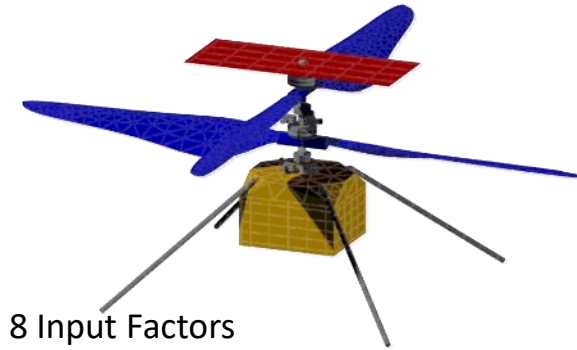


Mars 2020: Ingenuity Helicopter Mission Ops

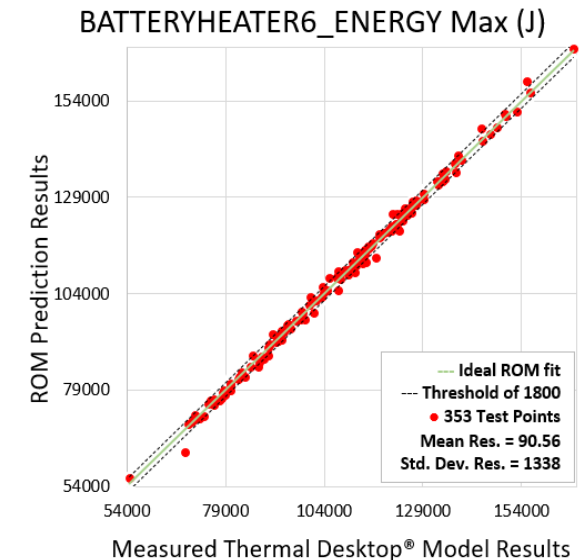
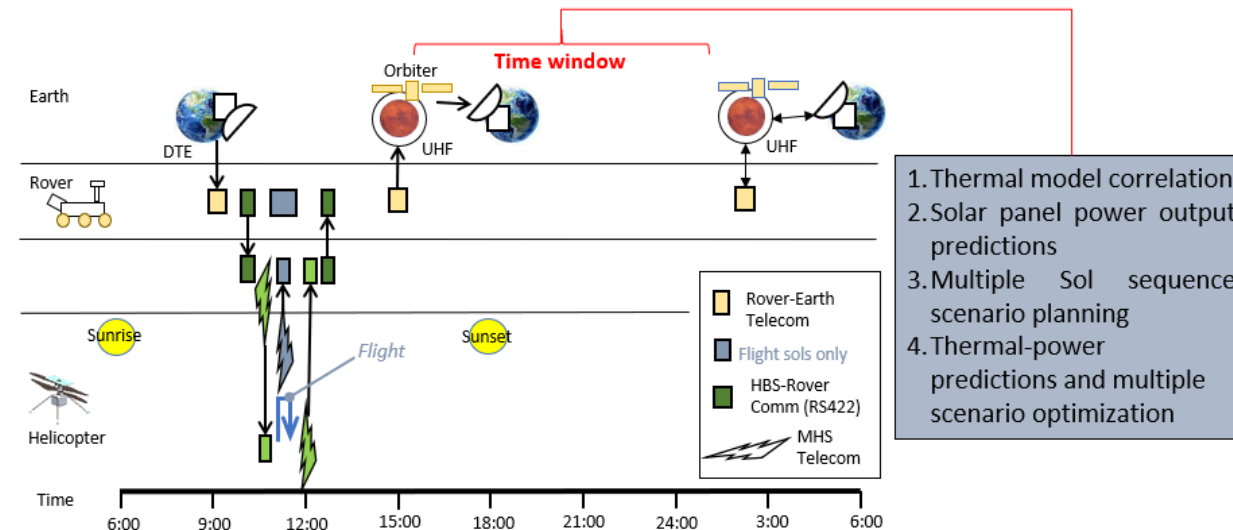
CUSTOMER SUCCESS STORY

Veritrek enabled instant exploration of thermal response scenarios

“Veritrek’s ROM has enabled more effective and efficient daily planning and operation of the Mars helicopter.”
NASA JPL, TFAWS 2020



8 Input Factors
19 Output Responses
3600 training runs



Test Results

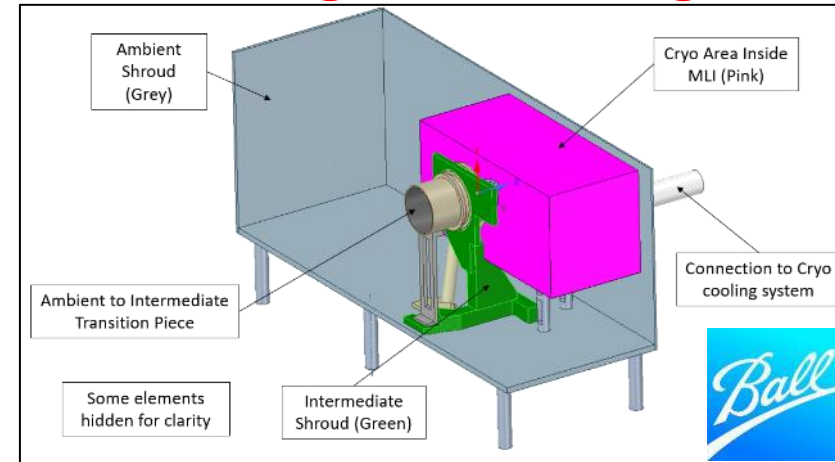
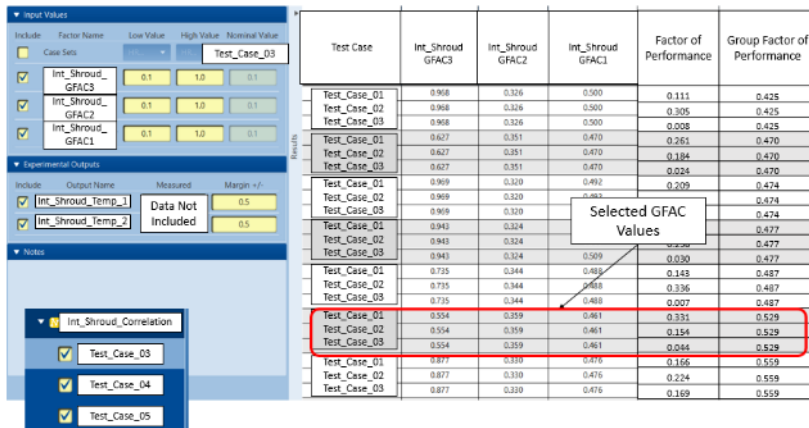


Ball Aerospace: IRAD

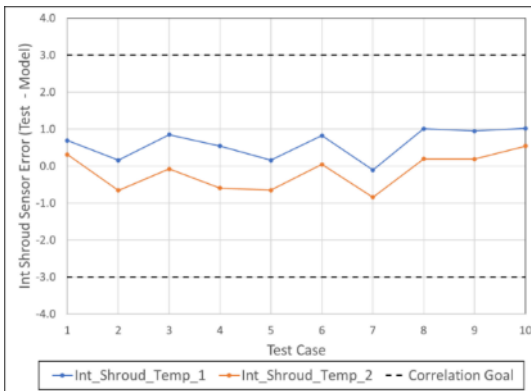
NEW CUSTOMER SUCCESS STORY

Veritrek enabled more in-depth understanding of the design

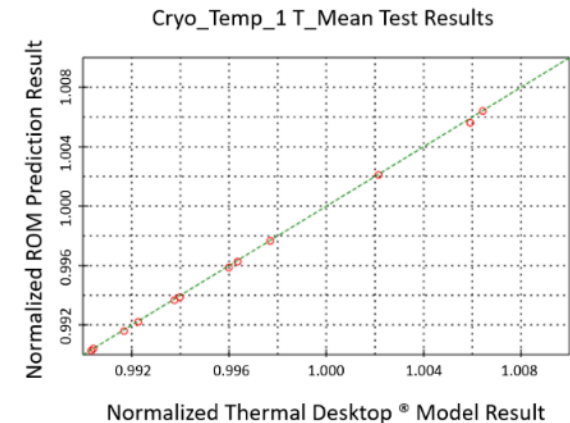
“Each ROM creation and correlation effort took 1 to 2 days, an effort that would have taken 3 to 4 weeks using traditional guess-and-check approaches.” *TFAWS 2021.*



16 Input Factors
17 Output Responses
208 training runs



Intermediate shroud correlation
20,000 ROM iterations produced 4500 solutions within +/- 1K across 10 different test cases





Conclusion

VISIT WWW.VERITREK.COM FOR MORE INFORMATION, CASE STUDIES, AND PUBLICATIONS

Start your 30-day free trial of Veritrek

- Thermal Desktop 6.0+
- Send MAC address to Jacob.Moulton@redwirespace.com for a license file and download link to the software



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MORE INFORMATION; BETTER SOLUTIONS



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NASA Marshall: Lunar Lander

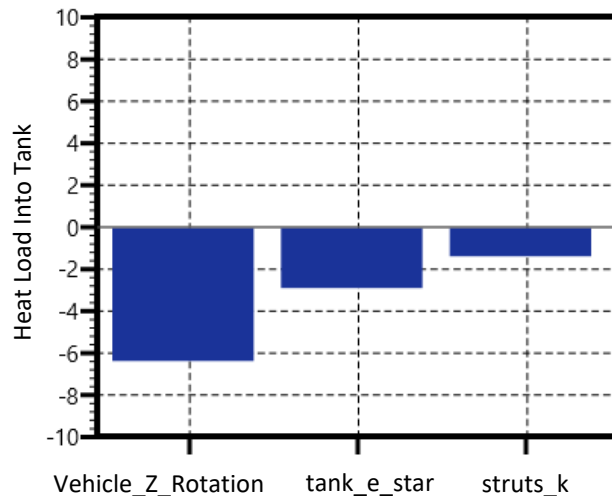
CUSTOMER SUCCESS STORY

Veritrek enabled sensitivity studies of a Lunar Lander cryo tank

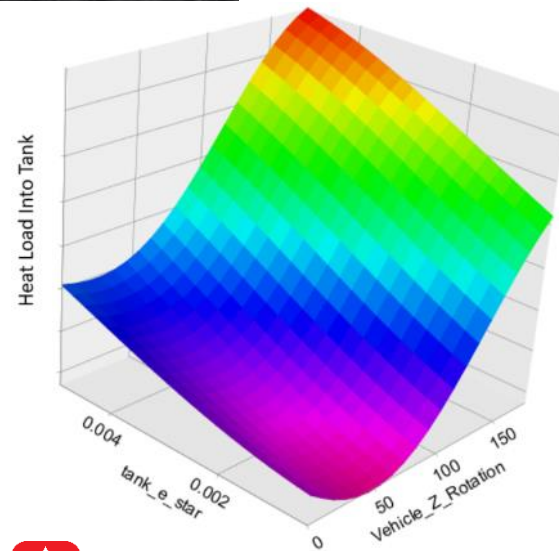


Actual TD model and thermal data not available for public release.

3 Input Factors
1 Output Responses
ROM creation (<1 hour)



Screening Analysis



Surface Plot Analysis



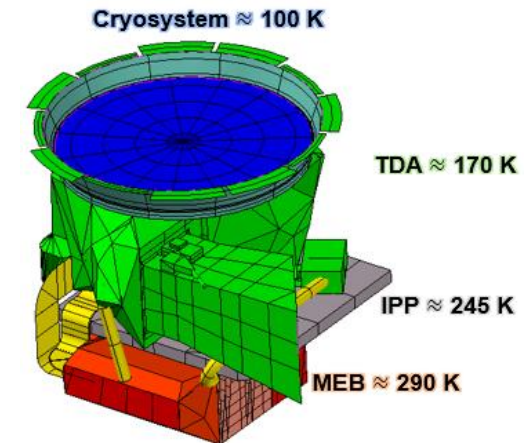
NASA Goddard: L'Ralph

CUSTOMER SUCCESS STORY

Veritrek's correlation process provided significant time savings



Veritrek identified multiple solutions that meet correlation criteria within seconds. Analysts can now visualize solution distributions to better select correlation settings. NASA TFAWS 2021.

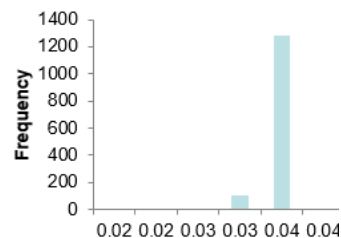


Correlation Analysis

Run Na...	Case Sets	LR_CorFar	LR_Emiss	LR_Emiss	LR_Emiss	LR_Estar_I	LR
Hot IPP	HotIPP...	1.3	0.83	0.8	0.83	0.15	
Hot LEI...	HotLEIS...	1.3	0.83	0.8	0.83	0.15	
Leucus ...	LeucPo...	1.3	0.83	0.8	0.83	0.15	
Hot IPP	HotIPP...	1.3	0.82	0.9	0.83	0.15	
Hot LEI...	HotLEIS...	1.3	0.82	0.9	0.83	0.15	
Leucus ...	LeucPo...	1.3	0.82	0.9	0.83	0.15	
Hot IPP	HotIPP...	1.3	0.82	0.9	0.82	0.14	
Hot LEI...	HotLEIS...	1.3	0.82	0.9	0.82	0.14	
Leucus ...	LeucPo...	1.3	0.82	0.9	0.82	0.14	
Hot IPP	HotIPP...	1.3	0.85	0.8	0.83	0.13	
Hot LEI...	HotLEIS...	1.3	0.85	0.8	0.83	0.13	
Leucus ...	LeucPo...	1.3	0.85	0.8	0.83	0.13	

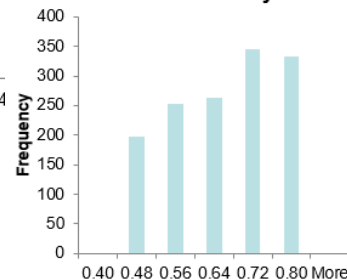
Deterministic Variable

IPP Estar

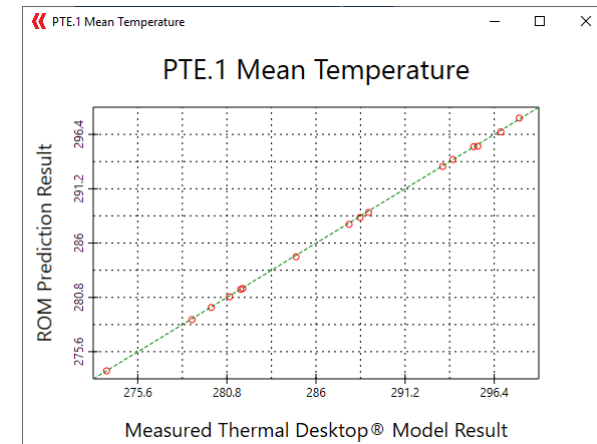


Indeterministic Variable

IPP Emissivity



15 Input Factors
~70 Output Responses
125 training runs (~25 hours)



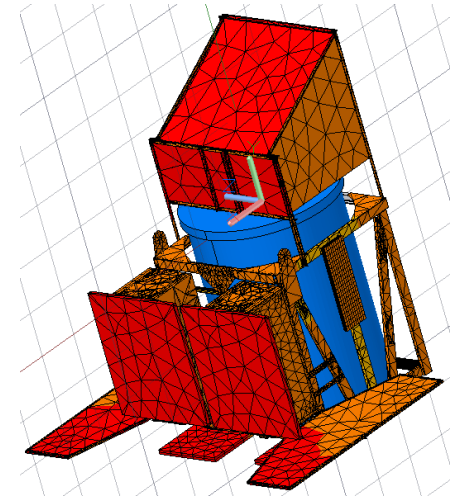
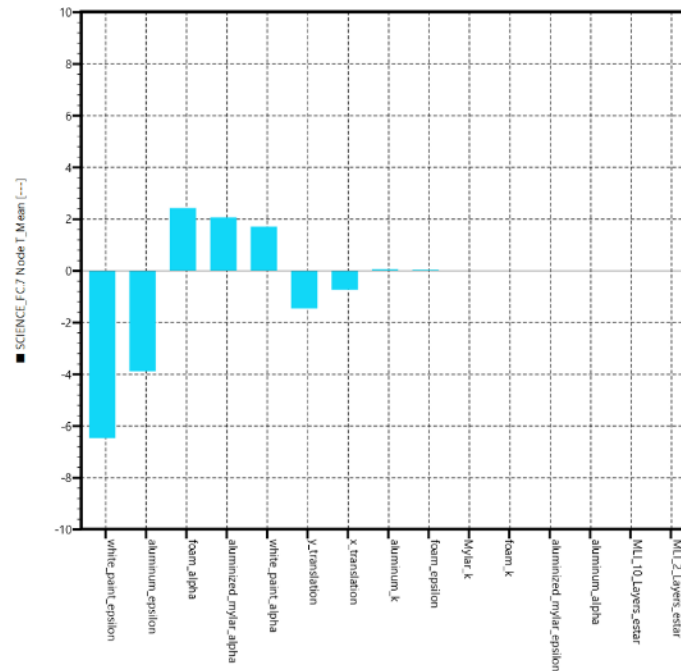
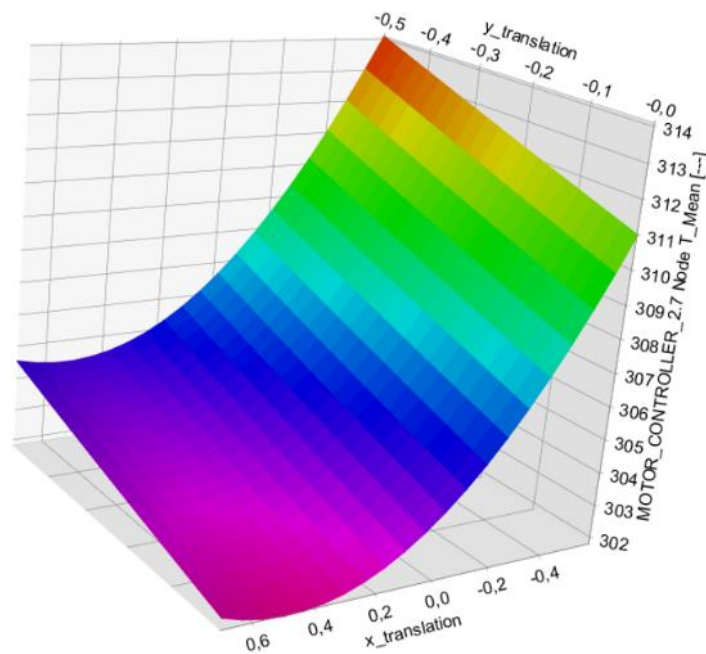


NASA Goddard: EXCLAIM Thermal Design

CUSTOMER SUCCESS STORY

Veritrek provided key thermal design insight

Veritrek allowed engineers to perform temperature sensitivity studies and determine the optimal component placement based on sensitivity results.



33 Input Factors
16 Output Responses
340 training runs (~84 hours)



Surface Plot Analysis



Screening Analysis

“Veritrek provided an in-depth understanding of the thermal design space in about 4 days, an effort that would have taken more than a week using traditional approaches.” (Jim Fouquet, Giuseppe Cataldo)



Sierra Nevada Corporation: Dream Chaser

CUSTOMER SUCCESS STORY

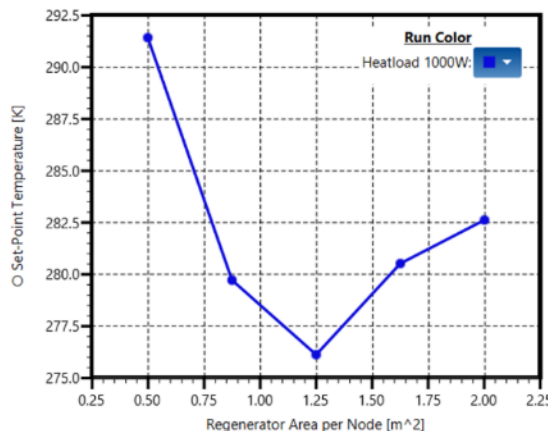
Veritrek enabled screening of many cases very quickly



Veritrek provided the team with quantitative data and rationale for selecting design solutions and satisfying requirements.

Actual TD model and ROM data not available for public release. Representative example shown below.

Traditional Results



Sweep through a few discrete points to locate minima and maxima.

Generate a 2500-point response surface in a few seconds.

Veritrek Results

